Urban Green Infrastructure

A Study of Implementation Strategies

By: Dee Merriam

Submitted to: Steve French, Ph. D.

Georgia Institute of Technology

Masters Option Paper

December 2010

Table of Contents:

"You never change things by fighting the existing reality. To change something, build a new model that makes the existing model obsolete."
R. Buckminster Fuller

Section 1- Problem Statement

The acquisition and management of natural systems is often fragmented and underfunded. The result is missed opportunities to leverage synergistic community goals. I plan to explore the concept of "urban green infrastructure" and the opportunities it presents for establishing systematic management of critical urban systems.

Introduction:
In many communities, the most visible public infrastructure is the street, space designed for the automobile. Public space, places where people meet and build social relationships, is constrained. Parks and sidewalks suffer from inadequate funding that limits access to the outdoors. Our ability to walk or bike as a transportation choice is restricted. The natural systems that inherently establish "place" are difficult to find in many communities. At the same time the costs of flooding, disrupted hydrologic systems, degraded water quality, and urban heat islands affect local economies. Local governments have a vital interest in all of these infrastructure-based issues. Yet organizational barriers often make it difficult to leverage the opportunities each of these infrastructures presents. Green infrastructure may provide a framework that allows for the development and management of systems that address social and environment issues in a synergistic fashion.

What is Urban Green Infrastructure:
When individuals live close together, their aggregate impact on their environment needs to be addressed methodically. After experiencing epidemics that devastated urban areas in the nineteenth century, we found ways to manage the systematic provision of safe drinking water, sanitary sewers, and garbage collection. This was accomplished through the creation of utilities supporting basic infrastructure. The public good of improved sanitation virtually eliminated devastating epidemics that ravaged industrial cities in the 1800s. As urban areas grow, the workings of natural and social systems also require our focused attention. Growing populations give us little choice but to be more systematic in their management.

A basic urban infrastructure is land that addresses both environmental and social issues. Environmental concerns include; climate mitigation, stormwater management, water quality, urban forests, and wild life habitat. Social concerns include; parks, active transportation systems (walking and biking), places for social and civic engagement, access to greenspace, education, and mental health. (Faber 2009; Farr 2008; Benedict 2006; Flink 1993) These diverse interests in outdoor spaces are effectively leveraged by building upon their natural synergies. Communities do not need to spend limited resources to acquire separate land for sewer easements and trail

systems, lands designated for stormwater management can also provide neighborhood access to greenspace, and street trees can help mitigate both stormwater and urban heat islands. However, the acquisition, design, and management of such land are often fragmented.

In order to capture the concepts of both environmental and social benefits I will use the following definition. (Other definitions are listed in Table 1: Definitions of Green Infrastructure)

> *"Green Infrastructure is a systematically managed network of open space that conserves ecosystems and provides associated benefits to human populations. This network includes wildlife habitat, water management, air and water quality, climate mitigation, urban forestry, urban agriculture, and the public realm infrastructure needed to support healthy lifestyles such as parks, sidewalks, trails, and street trees."*

This definition allows multiple environmental and social concerns to be addressed as a system. It fosters the idea that environmental interests in protecting animal habitat, water management, water quality, air quality, reduced energy usage, and climate mitigation can be leveraged with social interests in sidewalks, trails, parks, and access to greenspace.

Table 1: Definitions of green infrastructure

Conservation Fund*	At The Conservation Fund, we see green infrastructure as a network of natural areas and open spaces—such as woodlands, wetlands, trails and parks—that conserves ecosystems, helps sustain clean air and water and provides many other benefits to people and wildlife.
US EPA*	"Green infrastructure is an approach to wet weather management that is cost-effective, sustainable, and environmentally friendly. Green Infrastructure management approaches and technologies infiltrate, evapotranspire, capture and reuse stormwater to maintain or restore natural hydrologies." and in glossary..."An adaptable term used to describe an array of products, technologies, and practices that use natural systems – or engineered systems that mimic natural processes – to enhance overall environmental quality and provide utility services. As a general principal, Green Infrastructure techniques use soils and vegetation to infiltrate, evapotranspirate, and/or recycle stormwater runoff. When used as components of a stormwater management system, Green Infrastructure practices such as green roofs, porous pavement, rain gardens, and vegetated swales can produce a variety of environmental benefits. In addition to effectively retaining and infiltrating rainfall, these technologies can simultaneously help filter air pollutants, reduce energy demands, mitigate urban heat islands, and sequester carbon while also providing communities with aesthetic and natural resource benefits."
American Society of Landscape Architects*	"Green infrastructure can be considered a conceptual framework for understanding the 'valuable services nature provides the human environment.' At the national or regional

	level, interconnected networks of park systems and wildlife corridors preserve ecological function and create a balance between built and natural environments. At the urban level, parks and urban forestry are central to reducing energy usage costs and creating clean, temperate air. Lastly, green roofs, walls, and other techniques within or on buildings bring a range of benefits, including reduced energy consumption and dramatically decreased stormwater runoff. At all scales, green infrastructure provides real ecological, economic, and social benefits."
US Conference of Mayors*	"The US Conference of Mayors defines green infrastructure as the interconnected network of open spaces and natural areas, such as greenways, wetlands, parks, forest preserves and native plant vegetation, that provide wildlife habitat, natural drainage, recreational opportunities and help to sustain our Nation's cities..."
Environmental Council of States*	"green infrastructure is a cost effective and environmentally friendly approach to mitigating sewer overflows and works by diverting stormwater from the sewer system and directing it to areas where it can be infiltrated, evapotranspirated or re-used..."
University of Melbourne Green Infrastructure Research Group*	"Green Infrastructure is the network of designed and natural vegetation found in our cities and towns. It includes public parks, recreation areas, remnant vegetation, residential gardens and street trees as well as innovative and emerging new urban greening technologies such as green roofs and green walls."
Center for Neighborhood Technology http://greenvalues.cnt.org/green-infrastructure (8-2010)	Green infrastructure is the interconnected network of open spaces and natural areas, such as greenways, wetlands, parks, forest preserves and native plant vegetation, that naturally manages stormwater, reduces flooding risk and improves water quality.
Wikipedia http://en.wikipedia.org/wiki/Green_infrastructure (8-22-2010)	Green Infrastructure is a concept originating in the United States in the mid-1990s that highlights the importance of the natural environment in decisions about land use planning. In particular there is an emphasis on the "life support" functions provided by a network of natural ecosystems, with an emphasis on interconnectivity to support long term sustainability. Examples include clean water and healthy soils, as well as the more anthropocentric functions such as recreation and providing shade and shelter in and around towns and cities.
Green infrastructure Planning Guide, C Davies, R MacFarlane, C McGloin, M Roe.(adpated)**	Green infrastructure is the physical environment within and between our cities, towns and villages. It is a network of multi-functional open spaces, including formal parks, gardens, woodlands, green corridors, waterways, wetlands, forest, and open countryside. It comprises all environmental resources.
*http://www.greeninfrastructurewiki.com accessed 6-10-2010	
** http://www.landpolicy.msu.edu/modules.php?name=News&op=viewlive&sp_id=88 accessed 6-10-2010	

All of these definitions include a reference to the services provided by natural systems and the importance of connected networks. The Environmental Protection Agency and Environmental Council of States focus their definitions on water management. All the rest explicitly mention parks and/or recreation.

Background:
Most green infrastructure is a "public good." It is difficult to exclude individuals from the benefits, and because you benefit, the resource is not diminished. Left unregulated the public goods of sunlight, air circulation, water quality, the benefits of trees, access to greenspace, and connected transportation systems are likely to disappear as incremental market driven development occurs. It is a testament to the attractiveness of greenspaces that they are often included within private developments, but, as the value of land increases, these spaces become more compact and social disparities increase.

Simply stated as cities grow, their green infrastructure becomes more important. When communities are first settled their green infrastructure is obvious. The location of springs, creeks, rivers, and shorelines; woods and fields; ridges, valleys, and plains are important and shape the location of human settlement. Over time, people have developed machines and techniques that can mitigate the constraints these natural systems place on community development. If a creek is in the way, we can pipe it. If a slope is inconvenient, we can grade it. If a tree is in the way of a building site, we can remove it. As we take these steps each in and of it-self has little impact on the overall functioning of natural systems. However, done repeatedly over time they aggregate into major alterations and the natural systems that support our settlements begin to fail.

When miles of riverbanks are lined with dikes, floodwater accumulates as it flows down stream. Rains are no longer absorbed into adjacent flat lands and large amounts of water surges downstream. When the waters break through a weak point, areas once immune to rising waters are flooded. Similarly, one, two, or even three buildings have little impact on the heat an area absorbs. However, when vast areas are paved and allowed to soak up the sun's energy we begin to experience significant climate changes. We now talk of urban heat islands and can document that such areas are 2-22 degrees Fahrenheit warmer than the surrounding countryside. Shade trees have been shown to mitigate this impact and reduce energy consumption in nearby buildings. (Akbari 2005; McPherson 2005 b; EPA - Heat Island Impacts; Stone, 2007)

Greenways are a good example of synergistic land management. Healthy creeks and streams are important to our environment. They perform many services for our communities- they provide water and contact with nature, they mitigate urban heat islands and filter particulate matter from the air, they provide a place for us to play, gravity fed sewer lines follow their topography, they absorb and transport stormwater, etc. Establishing greenways along the creeks that wind through our communities has been shown to improve stream health by allowing them to function as a system. Yet due to fragmented responsibilities, the sewer department will

negotiate a construction easement with a developer, leaving the parks department to purchase a similar right of way for a multi-use trail, while another division of the public works department builds stormwater management systems that will pour polluted runoff directly into the waterway. The inherently elongated form of a greenway results in multiple access points and connects different parts of the city. When bordered by low volume, pedestrian friendly streets, greenways are highly visible, which enhances safety. At the same time, such streets can serve as buffers for streams. If buffering streets are designed to direct storm runoff into swales on their up-hill sides, they can provide stormwater storage. Multi-use trails can also be tilted away from streams to capture low-level storms. This technique allows water to seep into the soil, which both filters the water and stabilizes stream flow. Shallow swales can also capture floating debris before they are washed into streams. Vegetated stream banks support wildlife and shade the water while cooling adjacent areas. Contact with nature is increasingly recognized as an important human need, (Louv 2005; Jim, 2004; Kaplan 2004; Kuo 2001 a; Kuo 2001 b; Kaplan 1998) multi-use greenways create places for such contact.

Unfortunately, local governments often approach the delivery of services by assigning them to different departments with few incentives for them to contribute to each other's missions. This has limited opportunities to leverage cross cutting community needs. Green infrastructure can serve diverse populations and achieve multiple community goals. This is not a new concept. Much of Boston's Emerald Necklace was a sanitation project leveraged to create a public amenity. The Environmental Protection Agency issued a memorandum in the spring of 2007 recommending that water management agencies use green infrastructure approaches to water management due to their multiple benefits. (Grumbles 2007) With all the demands on local governments, they can no longer afford to ignore opportunities to leverage multiple goals. It is very expensive to duplicate services just because responsibilities are divided. It is easy to say that such collaboration is desirable but it is difficult to make it happen. Collaboration does take more time. It requires additional coordination. There are real concerns about conflicts or what happens when one department's needs change, but another one's do not. There must be an incentive for collaboration. Approaching these diverse community responsibilities as green infrastructure provides a framework within which that coordination can occur.

Need for Green Infrastructure:

Conservation interests have embraced the concept of green infrastructure as ecosystem conservation. The concept that animals benefit from nodes linked together via protected corridors is well established. (Weber 2006) Its roots in wildlife protection are reflected in definitions that focus upon natural areas. Water management and quality are also, often seen as a focus. The 1990s greenway initiatives noted the many community benefits that could be achieved by the synergistic management of ecosystems and introduced the idea that stormwater, urban forests, urban agriculture, parks, and trails could be managed as a system rather than disaggregated and managed by function. (Farr 2008, Benedict 2006, Little 1995, Flink 1993) Seattle's "Green Streets" explore the concept that urban treatments of stormwater and canopy trees provide similar synergistic opportunities. (Brice Maryman, EPA 2010)

In 2010 only 20% of United States census blocks have access to a public park within a half mile of its boundary. (CDC State Indicator Report on Physical Activity 2010) The public health costs of obesity and chronic disease are soaring as physical activity decreases. Our children watch television in part because the subdivision map drew lot lines to stream's center line, its banks are in private parcels, and their parents do not have time to drive them to the community park. The "Child and Nature" movement spurred by Richard Louv's concept that the lack of contact with nature may be partially responsible for the prevalence of children diagnosed with attention deficit disorder is gaining momentum. Louv makes a persuasive argument that many children rarely get to play outdoors and that contact with nature is a fundamental human need. (Louv 2005) In suburban areas, the travel distance to friends' homes can require an adult for transportation. The need to coordinate and plan trips out of the house eliminates opportunities for spontaneous gatherings. In urban areas, there may be no outdoor space within walking distance. The outdoor space may simply not exist in the area or such places maybe inaccessible because streets are not designed for pedestrians or the spaces are unsupervised and dangerous. In both suburban and urban contexts the location of parks in the community and the configuration of the streets serving parks are critical to park access. Clearly if a park does not exist in the vicinity, you do not have access to it. But, even when parks do exist, travel distance can preclude access. A city of Atlanta study of park access found that although 43.7% of the city's population lived within ¼-mile of a park boundary only 20.9% lived within the ¼-mile travel distance to a park entrance. (Giarrousso 2006)

Land dedicated as greenspace serves two primary goals: 1. the protection of lands for environmental reasons and 2. provision of places for people to enjoy. Parks are usually considered greenspace that has been improved for public enjoyment. Banerjee notes that parks serve as a civic resource, they are the "exception to the otherwise privatized world of city building," and represent an attempt to make cityscapes more human. He continues, "parks and open space in American cities have been identified with recreation, physical and mental health, communion with nature and the like, making them a public good and service. Inadequate public resources have left open space requirements advisory and unrealized. Furthermore, budget cuts after the mid-1970s had a disastrous effect on cities' ability to even keep up the current stock…. with declining maintenance, parks became vulnerable to abuses and were shunned by the public" P11 (Banerjee 2001). Finding the resources to acquire and manage these spaces has been a daunting challenge for struggling local governments.

Types of Land and services:

Land is fundamental to green infrastructure. It is establishes the space that supports both natural systems and a city's public realm. Streets, streams and floodplains and the land they occupy establish a basic framework. This framework is expanded to include; other sensitive lands such as steep slopes and fragile soils, active transportation systems, parks, sidewalks, street trees, and detention areas.

The interrelationship between these lands, their functions and benefits create opportunities for synergistic management. Table 2: Types of Land with Services, illustrates these interrelationships. Types of land are listed in rows while functions and benefits are identified in columns. Each cell is keyed as a primary function/benefit, secondary function/benefit, or not applicable. Such an exercise can be used to identify opportunities where agencies might benefit from combined resources to address both primary and secondary services.

Table 2: Types of Land with Services

	Stormwater Storage	Water Quality	Erosion Control	Wildlife Habitat	Hazard Mitigation	Climate Mitigation	Shade	Air Quality	Views	Active Transportation	Access to greenspace	Natural processes awareness	Civic Space	Cultural awareness	Physical activity	Social gathering	Reduced energy consumption	Enhanced land value	Mental Health	Fresh Food
Type of land																				
Functional Service P= Primary S= Secondary																				
Environmental																				
Urban forests	S	S	S	S	S	P	P	P	S	S	S	P	S	S	S	S	P	P	S	S
Stream banks	S	P	P	S	P	S	S	S	S	S	S	S	-	-	S	S	S	S	S	S
Flood plains	P	P	P	S	P	S	S	S	S	S	S	S	S	S	S	S	S	S	S	P
Detention areas	P	P	P	S	P	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Buffers	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	P
Ridge Lines	-	-	-	S	P	S	S	S	P	S	P	S	S	S	S	S	S	S	S	S
Sensitive Lands (steep slopes, unsuitable soils)	S	S	S	P	P	S	S	S	S	S	P	P	S	P	S	S	S	S	S	S
Ground water recharge areas	S	P	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Sewer Line R/W	S	P	S	S	S	-	-	-	S	S	S	S	S	S	S	S	S	-	-	S
Planted areas	S	S	S	S	S	P	P	S	P	S	P	P	P	P	S	S	P	P	P	-
Social																				
Parks	S	S	S	P	S	S	S	S	P	P	P	P	P	P	P	P	S	P	P	S
Trails	S	S	S	S	S	S	S	S	S	P	P	P	S	P	P	P	P	P	P	-
Sidewalks	-	-	S	-	-	S	-	S	P	S	S	S	S	S	P	P	P	S	P	-
Sensitive Lands (Cultural sites)	S	S	S	S	S	S	S	S	S	S	P	S	P	P	P	P	S	P	S	S
Urban agriculture	S	S	S	S	S	S	S	S	S	-	S	P	S	S	P	S	P	S	S	P

Types of land are listed in rows while functions/benefits are identified in columns.
Each cell is keyed as a primary function/benefit, secondary function/benefit, or not applicable.

Typical Goals for Land Acquisition and Management:
There are four common approaches to establishing goals for greenspace land acquisition:

1. The protection of significant sites and sensitive resources- our national parks are examples.
2. Population ratios such as 10 acres/1000 population (Lancaster 1983)
3. Percent of land area- the Georgia Community Greenspace program recommended 20% of a community's land area and NRPA Park and Recreation Standards and Guidelines recommended 25%.(Ga Greenspace Committee 1999; Lancaster 1983)
4. Access- Assuring that a significant portion of a population has access to a park within a ½-mile walk.

Each has inherent strengths and weaknesses; however, one does not preclude another. Used together they could result in the development of a robust greenspace system. Used with the concept of green infrastructure, they can guide and leverage limited government resources.

1. The protection of significant sites and sensitive lands
One of our strongest impulses is to create parks in order to protect **significant lands**. The importance of a particular site could be its scenic, environmental, cultural, or historic qualities; examples include Atlanta's Stone Mountain and Yellow Stone National Park. These sites inspire protection due to qualities inherent in the land itself. Therefore, they are known and remain stable as populations change. They often engender emotional attachment and are acquired and placed in parks for safekeeping. Problems occur when underfunded park systems try to use such sites in ways that conflict with the reasons they were created.

When local governments acquire sensitive lands their resources are often limited, as a result the property boundaries maybe drawn with inadequate buffers. Such properties require space to accommodate both supportive maintenance and programming. Site boundaries that are drawn strictly around a resource with no buffer or space for either maintenance or supportive programming can lead to degradation of the resource. Sites established to protect sensitive lands may also suffer as local agencies struggle to support recreation programs that are in high demand. Underfunded local governments may have little choice but to compromise the lands that they have in order to meet citizen demands for activities incompatible with the site. Greenways begin to address streams as a system, but still miss the over arching concept of green infrastructure as an interrelated whole.

Regulations are also used to protect sensitive lands such as stream banks, wet lands, and flood plains. Such regulations are usually designed to prevent development within a sensitive site and may fail to provide for public access.

2. Population ratios
In 1983, the National Recreation and Park Association (NRPA) published Recreation, Park, and Open Space Standards and Guidelines. These were recommendations for lands and facilities that a community should provide for its citizens. Most of the standards were presented as per capita

goals expressed per thousand population. If you anticipated **x number of citizens then you needed x number of acres or facilities**. Benefits include the ability to normalize the measures and compare service levels for different size communities. It is formula driven and appears very scientific and objective. Data are relatively easy to obtain. Linking need to population provides some guidance for facilities, but it is not as useful for guiding land acquisition.

Early criticism with this method was based upon its assumption that all facilities of a particular type are equal and that all citizens will use them in similar ways. Applying this method to land acquisition has a fundamental problem- the availability of land has an inverse relationship with population. When populations are small land is abundant, but the formula indicates that few park acres are needed. When the population increases and more land is needed, land becomes progressively more scarce and expensive. In very densely populated areas, you must reduce the recommended level of service or you could be in the untenable position of recommending more acres of parkland than exist in the community. At less extreme levels, planners find themselves chasing ever-changing goals. The greatest flaw with this approach is its failure to provide appropriate guidance at a time when effective action can be taken to acquire land and limit the development of hazardous areas such as flood plains. It lulls a community into believing it has adequately provided for its citizen's needs at the point in time when establishing parks and acquiring sensitive land would be the least disruptive and expensive to accomplish.

3. Percent of land area

Another method is to establish a goal of protecting a percentage of a community's land area in parks. Such an approach provides a stable reference point. Communities are encouraged to protect land when it is readily available and its acquisition does not disrupt other uses. In 1969 the NRPA recommended that a minimum of 25% of a community's total land area be protected.(Lancaster 1983) The Georgia Community Greenspace program required that participating jurisdictions stipulate in their Comprehensive Plans a goal of permanently protecting at least 20% of their land area. It would be advisable for communities to inventory their sensitive land and use this information to determine the amount of land it should protect.

It is common for sensitive lands to become the focus of community concern after a major project has been announced. Efforts to protect sites from imminent destruction can proceed without a long-term plan as to how the site will be used. Last minute compromises can result in the creation of a site that functions poorly. The systematic planning fostered by a percentage goal encourages communities to identify sensitive lands in a pro-active way and to include them within their green infrastructure system.

4. Access

Park access can be defined by the percent of a population that can reach a park site within a given time or travel distance. Placing parks so that they can be reached within a ½-mile travel distance is an example. Because it fosters a large number of dispersed sites this kind of goal can be difficult to manage. Yet such a goal becomes more important as population density increases.

As people live closer together individuals no longer have access to private outdoor space and the common yard becomes increasingly valuable. Providing parks that most people can walk to is a goal that can only be achieved if a community has strong incentives and a process to create parks incrementally as it grows or redevelops. Access to parks as part of daily living is critical to making dense urban living attractive and is becoming increasingly important in the United States.[1]

Goals Discussion

All of these approaches to the acquisition and management of land have strengths and weaknesses. Used together they can support an evolving green infrastructure. How public land is used changes over time. People move in and out of communities. Populations grow or dwindle. The demographic makeup of an area shifts. But the need for public land, for places to be outdoors, to have contact with growing things, to meet neighbors on a neutral site, to have places that allow freedom of movement and opportunities for group games continues.

The protection of sensitive lands such as flood plains or important cultural sites can be reinforced by understanding that the protection of a percentage of the jurisdiction's land area is desirable and that accessible sites close to where people live become increasingly important as a community grows. These goals can be articulated as green infrastructure in the community's comprehensive plan. Implementation is best done early in a community's development, but can be realized over time by establishing incentives and processes that encourage the creation of connected systems. Few cities have the resources to create such systems during one administration or even one lifetime, but such green infrastructure is needed to support healthy communities. Viewed as such, overlapping government services can be leveraged and communities can find the resources needed to be places people want to live.

Techniques for Managing a Community's Green Infrastructure:

Opportunities for the multiple use of space occur throughout our communities, these opportunities can be leveraged as green infrastructure. This section explores some of the techniques that can be used as indicators that a community proactively leverages its green infrastructure.

Sewer Lines - Public access right-of-ways can be negotiated as part of the property dedicated for sewer trunk lines. The construction road can become a multi-use trail that enhances the sewer department's access to their lines. In addition, multiple use may justify wider buffers, which provide increased filtration, ground water infiltration, and flood storage.

Detention Ponds- can be designed to not only store stormwater, but to also create accessible greenspace and improve water quality. These are more effective when designed to serve a

[1] It is estimated that 84% of the US population now lives in metropolitan areas, defined by the US Census as a city with a population of over 50,000. (Bradley 2010)

neighborhood or district. Communities are rethinking ordinances that require every parcel to construct a detention site in favor of mechanisms that support more holistic approaches.

Canopy trees- are not just about making a street more attractive. They can filter air pollution, mitigate the urban heat island, reduce stormwater runoff, and extend the life of asphalt paving. Programs, design guidelines, and regulations that support adequate space for mature street trees are needed.

Conservation Subdivisions- Randal Arendt, in Conservation Design for Subdivisions identifies two broad advantages to the development of conservation subdivisions: Environmental / Ecological and Social / Recreational (Arendt, 1996). In both cases, he is promoting the concepts of identifying and protecting sensitive lands and creating accessible places for people to informally meet each other and enjoy being outdoors. Ian McHarg's seminal book Design with Nature suggests the identification of sensitive lands as the first step in the design process (McHarg 1965). Arendt concurs, adding that the protection of these lands should drive the rest of the site design (Arendt 1996). Fredrick L. Olmsted eloquently articulated the need and opportunities for public access to open spaces. He became the spokesperson for the public parks movement (Fisher 1986). He felt that as cities become more densely populated parks were needed as "the lungs of the city." They were important not only for physical exercise but also as a place where different layers of society could mingle. (Fisher 1986) Research by Rachel Kaplan and others has linked the exposure to natural settings to human psychological needs (Louv 2005; Jim, 2004; Kaplan 2004; Kuo 2001 a; Kuo 2001 b; Kaplan 1998)

Green Infrastructure Utility- A green infrastructure utility could provide the framework required to leverage the collaboration discussed above. This concept is an expansion of stormwater utilities that have been used to fund the management of stormwater systems.[2] The utility allocates a percent of its revenue for the planning, acquisition, management and community outreach related to green infrastructure. Stormwater utilities are often based upon fees determined by the amount of impervious surface on a site. In addition to this approach, a green infrastructure utility could base its fees upon cost avoidance calculations. The green infrastructure management team is able to provide incentives for improved approaches to water management and other green infrastructure services. Funds are available to acquire and enhance key properties and additional properties that are acquired through incentive programs. Staff is funded and trained as long-term points of contact. Their role is to develop good working relationships with property owners and local developers as part of outreach initiatives. Implicit in this concept is the ability to use the land for public purposes such as sidewalks, trails, interpretive centers, and recreation. In the 2007 citizen's survey conducted in the city of Atlanta, over 80% of those polled supported dedicated revenues being used for greenways that included

[2] A stormwater utility has the ability to collect fees on those who use its service and can be based on the amount of run-off typically produced by different land use classifications.

environmental protection, trails, playgrounds, picnic areas, open fields, and community gardens. (LeisureVision 2007) Because street trees and detention areas can also be leveraged to both improve access to greenspace and water management they too could be managed as part of a green infrastructure utility.

Leveraged Partnerships- Rapidly urbanizing areas experience tremendous development pressures. In some areas governments are initiating greenspace protection programs. These programs would have significantly more impact if they were designed to leverage public / private partnerships. This requires significant coordination. A model for this type of outreach and coordination is the "Main Street Program" used to leverage partnerships within a community's business district. Main Street Programs received seed grants to encourage the hiring full time dedicated staff. The program articulated broad goals and principals that provided stable direction and evaluation of changing strategies. Communities committed to long range planning received technical support from the parent organization. Staff had regular opportunities to attend workshops and compare experiences with others doing similar work. Staff were trained to implement local plans using communication pieces and consensus building. They were encouraged to reach out to potential partners in a sustained fashion and became a consistent point of contact assisting in implementing the community's plan over many years.

Greenspace programs have significant parallels to Main Street. Many layers of public and private interests are involved. Along a main street independent retail businesses are glued together by the public road and governmental climate. Successes and failures are determined by a combination of individual, group, and public initiatives. Decisions made in isolation, while valid and sensible on their own, often miss the opportunities for synergy that lead to everyone's success. In most cases isolated efforts have minimal opportunity for success or require massive investment.

Green infrastructure faces many of the same challenges. There are the overriding public needs to protect sensitive lands and provide opportunities for people to connect with each other and the land. Providing these opportunities improves the viability and marketability of both residential and commercial developments. The difference is that with green infrastructure the scale is much broader. You do not have a targeted street, instead you have a network of streams, corridors, and nodes. But, there are many similarities. Green infrastructure programs have many independent private interests that are affected by public policies. In both cases, isolated decisions can lead to missed opportunities. There is the opportunity to improve profitability and environmental impacts by coordinating efforts. You have the opportunity of greatly improving a community's quality of life through the coordinated efforts of those who develop and manage the community's infrastructure. Main Street success factors can be adapted to leverage community green infrastructure.

Transfer of Open Space- In order to promote the circulation of air and access to sun light, many development codes require that a percentage of a site's land area be maintained as open space.

This can result in awkward, poorly functioning space. Instead, a block can be targeted for acquisition and redevelopment as green infrastructure. Properties within a prescribed distance of the site would have the option to buy-out some of their required open space by contributing to the green infrastructure fund. Contributions would be based on the value of the developer's land. The funds would serve as a mechanism to transfer and consolidate awkward on-site open space to the nearby site. To start this process a local government could establish a revolving fund that is used to acquire and develop sites geographically linked (within a .25 mile walk) to eligible developments.

Street Patterns and Greenspace- The location of greenspace entrances and adjacent street networks play important roles in determining access. A neighborhood with many intersections (small blocks) allows multiple route choices and results in shorter travel distances for people who do not live next to the site. A site with only one entrance forces all users to enter at that point, someone unfortunate enough to live on the back side of a site has to make an extended trip.

When streets abut a site, they increase its visibility. People driving past can enjoy the view and at the same time provide informal security for the areas they observe. Streets are interesting edges that both connect and separate. Private back yards that abut public space create an awkward dynamic. The public users feel that they are intruding on domestic space and the homeowner feels exposed as strangers observe domestic chores. Placing a pedestrian friendly street along the edge of a park or greenway helps establish the site as a place that is owned in common.

As density increases greenspace becomes less available and more important. Density occurs incrementally, so how can a community anticipate this need? A first step is to establish a goal to protect a percentage of land area. Then allocate this land to protect significant sites and sensitive lands with buffers adequate to support synergistic activities and supporting infrastructure. Assure maximum access to the protected land by creating walk friendly streets. As land is incrementally developed, establish incentives and procedures that foster the creation of parks and greenways. At the same time, assure that streets provide adequate space for canopy trees, attractive sidewalks that allow people to walk in groups, street furniture, and bike lanes. This usually happens as land is subdivided; therefore, supportive subdivision codes are critical to creating an accessible green infrastructure. Resources and staff dedicated to leveraging opportunities are required.

Conclusion:
If we wish to reduce the environmental impact of growing populations, we need to make living in dense environments attractive. Urban areas have much to offer in terms of quality of life. Dense settlements make specialty shops, libraries, theaters, and a rich social life possible. Attractive, easily accessible greenspace is an important consideration when people choose where to live. The more intense the development, the more important the greenspace becomes.

Yet without establishing space for green infrastructure early in the development of a community, it becomes difficult and expensive to retrofit communities. If we were to embrace the idea that a percentage of an area should be permanently protected as public greenspace, we would be able to better plan for the future. As populations grow the need for this space increases. If there is no goal established when land is available, before investments have been made in traditional infrastructure, it becomes difficult to retrofit green infrastructure into communities.

Communities can decide to leverage green infrastructure with other government services. First, there must be a long-term vision. A plan that indicates land that should be included in the greenspace system is required. The mapping now available through Geographic Information Systems (GIS) makes the analysis of opportunities practicable. These plans need not be expensive or time consuming to develop. Many communities already know the extent of their 100-year flood plains and with GIS; it is a simple matter to add a buffer of a specified dimension. The flood plain, other sensitive lands, and the buffer become an area of interest. Parcels with ownership data are easy to overlay and provide valuable insights about what is feasible at any given time. New projects that overlap the area of interest are flagged for special review. It is important that the local government have a process in place that allows projects of interest to be reviewed early by trained staff. If the project is reviewed before a significant investment has been made in the development of site drawings. It is easy to convince a developer that creating an amenity out of land that he thought would be a liability is in his best interest. It is nearly impossible when this work is well underway.[3] Developers also like the idea that their amenity maybe leveraged by synergistic work on adjacent lands. In this way, the community can incrementally build its green infrastructure by simply having a vision, a supportive process, and trained staff.

[3] Changes in a project concept made after engineering assumptions have been settled result in cascading changes, inflating costs, and extending project schedules.

Section 2- Research

In order to develop a better understanding of how green infrastructure can be implemented by local governments, this section explores the approaches used by selected. Planning, public works, and parks department policies in communities that have shown leadership in leveraging social and environmental infrastructures serve as case studies.

Material from comprehensive plans, parks and open space plans, and general information available from community websites is presented. Public officials such as lead staff managing programs within Public Works, Planning, Parks and Recreation, and Water Management Departments discussed their programs and provided valuable insights into approaches to green infrastructure. See Appendix A – Interview Guide

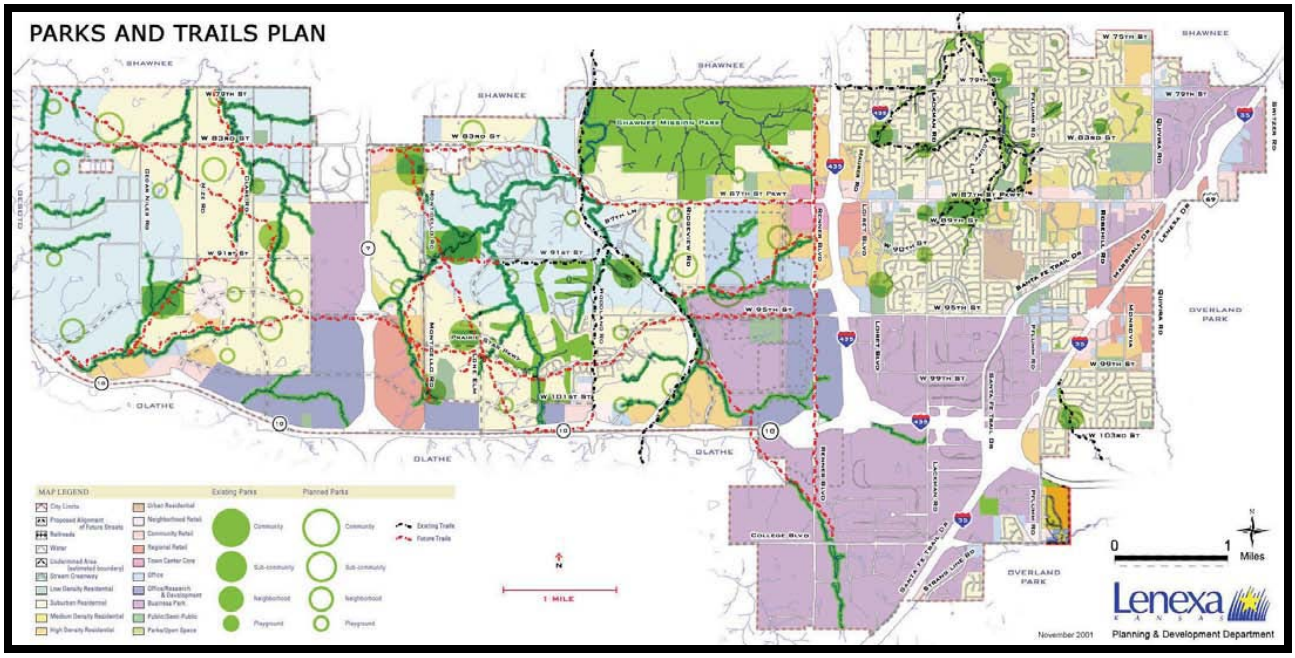
This study is not exhaustive; rather, it serves as an initial scan of how communities are leveraging their environmental and social goals to create integrated systems. Four communities are investigated:

- Lenexa, Kansas
- Philadelphia, Pennsylvania
- Raleigh, North Carolina
- Seattle, Washington

Appendix B provides an overview of each of the case study communities. The overviews include baseline data such as the age of the community, 2000 census population, geographic location, and size. It also includes an outline list of key planning initiatives, implementation factors, and a time line of relevant events.

Case Studies

Lenexa, Kansas



Lenexa, KS Parks and Trails Plan- Targets stream protection

Lenexa, KS is located 12 miles southwest of Kansas City, KS. In 2000 its population was 40,238 and it included a land area of 34.4 square miles.

In 1996, suburbs of Kansas City, Kansas were experiencing growth pressures. As a result, the City of Lenexa initiated a citizen-driven long-range plan, Vision 2020. Surveys and discussions indicated strong support for a program that leveraged water management and outdoor recreation needs.[4] In 1998, this part of Kansas experienced heavy flooding made worse by episodes of flash floods and resulted in the loss of life. At the same time, the Public Works Director was aware of the Environmental Protection Agency's concern with water quality. He anticipated National Pollutant Discharge Elimination System (NPDES) regulations that would require a greater focus on water quality. The Parks Department held land that could be leveraged to create a regional park with a 35-acre lake, such a lake could also help manage major storm events. These factors established a foundation for an initiative to leverage recreation and water management in a new program.

The City's website notes that in Lenexa they view "stormwater as an amenity, not a liability." (Lenexas, KS web site) The program, called from "Rain to Recreation," was born within the

[4] Rain to Recreation Summary notes- that surveys indicated 80% of the responders would be willing to pay for a program that reduced flooding, conserved water quality, restored and protected the natural environment, and provided for recreational and educational opportunities.

Public Works Department in 2000. The approach has resulted in multiple techniques designed to leverage several community goals. These goals explicitly address environmental, recreation, education, and access to outdoor space. The techniques include: planning, policy, organizational structure, regulation, inspections, outreach, and programs. These techniques are supported through resources made possible by multiple funding streams: the community's general fund, ten years of sales tax revenues, a stormwater utility fee, and development impact fees.

Planning

The Lenexa program was born in their Vision 2020 plan. Early successes grew out of the direction and goals established in the community driven recommendations. Surveys indicated that eighty percent of the responders would support a systems approach to stormwater management that included access to trails and parks. The City notes that it was important to create a comprehensive plan based on a stream inventory and opportunities to create parks and greenways. The adopted map, which identifies priority sites, provides guidance for the review of development proposals and targets sites for direct acquisition. Coupled with supporting regulations and incentives it serves as a tool for methodically building a greenspace system.

Development reviews include:

- A free consultation that allows departments from across the jurisdiction to flag issues and opportunities when the project concept is under development- The Parks Department is informed of these meetings, but currently do not have anyone assigned to participate in them on a regular basis. The Parks Director noted that he would like to make such an assignment but does not have the staff resources. However, the city planner is aware of park needs and flags appropriate projects for special reviews.
- Preliminary reviews begin the formal review process. Developers must submit letters that confirm their contact with state and federal agencies responsible for environment reviews.
- Final reviews require official environmental responses to the purposed development.

Open Space is required as part of subdivision review and the Parks Department does evaluate opportunities to improve visibility and access.

Lenexa will initiate its first comprehensive parks master plan in 2011. They anticipate establishing park classifications and goals as part of the planning process.

Policy

"Rain to Recreation views stormwater as an amenity, not a liability, and focuses on green infrastructure solutions to prevent pollution and reduce runoff, achieving compliance through community commitment." (Lenexas, KS web site) With this underlying policy statement guiding the City's actions opportunities to leverage multiple community services are supported. The City created a Watershed Management Division within its Public Works Department in 2000. This division was charged with managing the establishment of the Rain To Recreation Program. It has

overseen land acquisition, project management, adoption of regulations, public outreach and education, site inspections, and system management.

Organizational Structure
Because the City is small, its staff comes into regular contact with each other. There are informal opportunities for them to learn about the goals and challenges of other departments. Much of the communication required to coordinate initiatives occurs due to personal relationships. Vision 2020 and the creation of a Watershed Division within the Public Works Department were citywide events and everyone knew about the Rain To Recreation concept. Even so, staff directly charged with its implementation and management make a point, not only be accessible, but also to provide training and awareness programs targeting internal staff.

Regulations
In 2000, the City had a clear direction to create a water management system that leveraged opportunities for outdoor recreation and revenue streams from a .125 sales tax and stormwater utility fee. Nevertheless, it understood that supportive regulations would also be required to create a connected system. The community adopted a series of regulations designed to promote the system.

A Stream Setback Ordinance based on an inventory and evaluation of stream quality required a minimum 50’ setback on all streams and provided for wider setbacks for priority streams.

The community worked with professional organizations in the region to create a Best Management Practices Manual that provides guidance on techniques that reduce stormwater runoff, promote the filtering of non point source pollutants, and encourage ground water recharge. This is used in conjunction with a Unified Development Code that mandates the on-site treatment of low-level storms.

Inspections
Interviews with city staff have emphasized the need to inspect both public and private installations on a regular basis. New techniques for filtering water through bio-swales and rain gardens require reinforcement and training before property owners and maintenance crews become accustomed to their care.

Outreach
Once the concept of Rain To Recreation was established care was taken to explain the benefits to the general public and key stake holders. The City held its first WaterFest celebration to make the connection between water and public amenities prior to the 2000 vote on the sales tax. They have been held annually ever since. In addition, the city deliberately worked with key stakeholders such as the development community to make sure they both understood and had compelling reasons to support the initiative. A full time staff member coordinates the dissemination of information through various mediums and helps organize educational

programs and events with the help of the Parks Department. The conscious use of community events, education programs, and media keep Rain To Recreation goals and opportunities fresh and alive for Lenexa's citizens.

Funding
The City provided funds for the program out of its general fund until 2006.

Sales tax initiatives passed by wide margins in 2000 and again in 2004. In place through 2010, they have been the primary source of funds for the acquisition and development of the system. These funds were critical in allowing the city to acquire land and develop the appropriate regional infrastructure prior to development.

The City's Stormwater Utility, established in 2000, charges property owners fees based on the amount of a site's impervious surface. The funds support on-going management of the system. The Stormwater Utility fees go to the Public Works Department and appear to have been designed to address only the management of the water management aspects of the system. The Parks Department is anticipating the need for another sales tax to support the development of recreational components. They are waiting for the development of a 2011 Parks, Recreation and Open Space Comprehensive Plan to provide guidance for their needs.

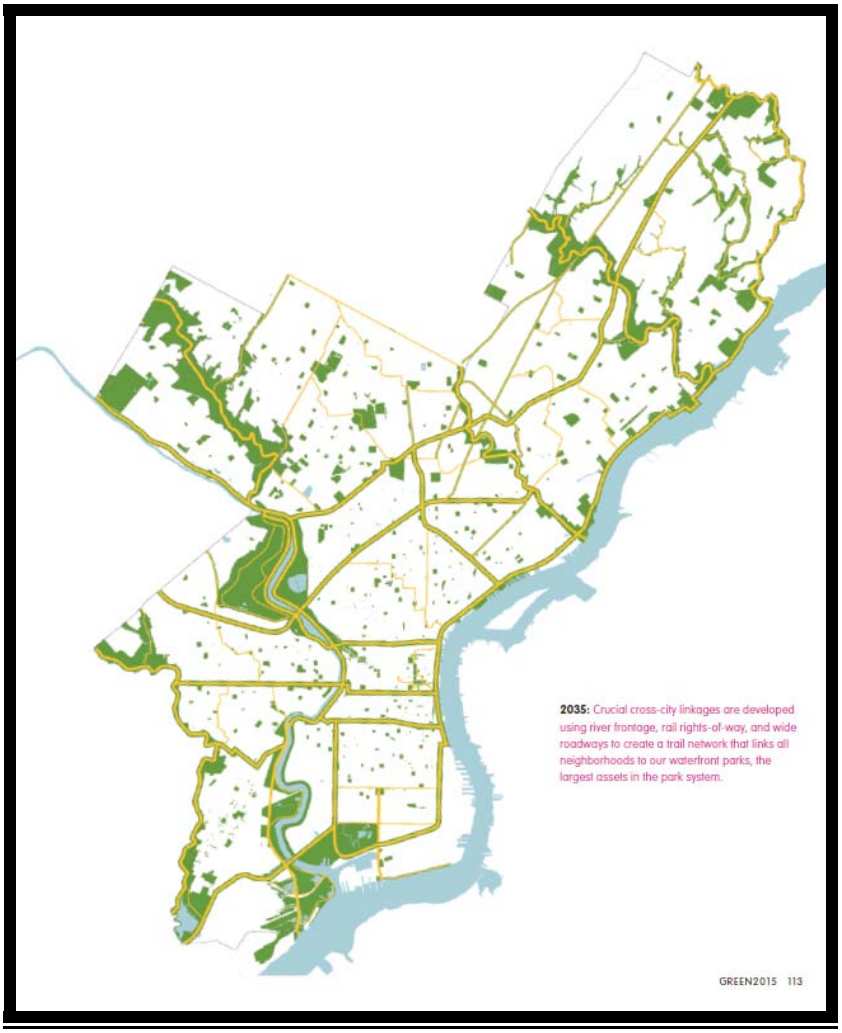
In 2004 the estimated capital cost of "built-out" water management required by impervious surface was $61,000,000. This figure was used to generate a "system build out" charge based upon the impervious surface generated by an equivalent dwelling unit. (Beezhold 2006) The cost of land and infrastructure required to manage the stormwater generated by major storms was explored with the development community. Who, when given the choice of creating and managing on-site facilities designed to handle major storms versus contributing funds toward the creation of a regional system that included community amenities, supported the payment of a fee at the time building permits are issued.

Summary
Although Lenexa's Rain to Recreation program has been focused on stormwater and managed as a capital program within the Public Works Department, it was structured to acquire property that could be leveraged to support parks and trails. The Stream Set Back Ordinance anticipates recreational uses and requires a 25' outer zone along all streams. Because the City anticipated the creation of parks, land acquired for regional storm water lakes was significantly greater than required to strictly to support the lake and forebay filter areas. For example, 240 acres were acquired for Black Hoof Park that contains the 35 acre Lake Lenexa. As of 2010 most of the priority lands have been purchased and several of the lakes are functioning as regional detention facilities. The stream corridors have been established. The Public Works role is evolving into site maintenance. The City has positioned itself to receive multiple benefits from its investments in water management by leveraging those sites to support opportunities for recreation. Currently the Parks Department is initiating its first comprehensive plan. It will be interesting to see how

the structure established by the needs of water management will serve as the skeleton of a park system.

Lenexa's integrated approach to leveraging water management and outdoor recreation required a vision, a plan, funding, organizational structure, regulations, inspections, community outreach, and regular community contact that emphasized the benefits of the system.

Philadelphia, Pennsylvania



Map from: Green 2015 report: 2035 vision of cross-city linkages

Philadelphia's founder, William Penn, envisioned a "greene countrie towne." He established a framework of broad streets and squares between the Schuylkill and Delaware Rivers in 1681. The City lies in the southeast corner of Pennsylvania and is approximately 50 miles west of the Atlantic Ocean. The site provided an excellent port in protected waters. Today the City covers approximately 135 square miles. In 2000 the City had a population of 1.5 million, having lost population from around 2 million in the 1950s.

The City has a long history of park acquisition and understanding of multiple benefits. In 1810 the "Faire Mount" property was acquired for the construction of a Water Works on the Schuylkill River. The Water Works managers established trails and gardens that welcomed public visits. The Water Works' South Garden was a very popular tourist destination throughout the 1800s. Over the years additional land was acquired along the river for the protection of Philadelphia's

drinking water and recreation opportunities. These properties included historic farms, estates, and manor houses. By 1867, the City had created a system of nearly 4,000 acres and established the Fairmount Park Commission for its management. The Water Works were decommissioned 1911. However, the Fairmount Park Commission continued to manage the City's growing park system. (History of Fairmount Park 2010) In 2004, this was a system of over 9,000 acres, 10 percent of the City's land area. (Bridge to the Future 2004) 2010 saw the merger of the Fairmount Park Commission with the Recreation Department creating a newly combined Department of Parks and Recreation.

At the end of the twentieth century, the US Department of Environmental Protection began to issue regulations forcing communities to deal with water pollution caused by combined sewage overflow systems. This encouraged the City to develop its "Combined Sewer Overflow Long Term Control Plan" in 1997. A recognition of the interplay between various programs led to the 1999 creation of the Office of Watersheds. This action merged the Combined Sewer Overflow, Stormwater Management, and Source Water Protection programs. (Green City:Clean Water 2009).

Planning

In 2006 the City initiated a new approach to open space planning, one that recognized the inherent synergies between many local government services. The resulting plan was not published until 2010 but had influenced its sustainability efforts. The plan began by crafting a 'Sustainability Framework' to,

> "… guide key initiatives and monitor and document its impact. By measuring, gathering and mapping key data indicators, the City is able conduct a comprehensive needs analysis to determine how to strategically invest in open space. The data will also serve as a baseline against which the City can measure progress and impact. Another innovation worth noting is an extensive cost-benefit analysis that will enable the City to calculate the return on investment for funds invested in open space." (Philadelphia Sustainability Awards 2008 Nominations)

Input for the plan came from federal, state, and city resources. It brought together 14 Philadelphia government agencies, stakeholders, and many organizations with common agendas.

> "… the process encouraged new ways of thinking about open space, much needed coordination and collaboration, and a greater understanding of how citizens, business owners, and community groups understand open space. …. GreenPlan Philadelphia provides a powerful tool to use the City's open space resources in a way that improves the environment, increases the quality of life for everyone, and bolsters the economy while conserving natural resources." (Philadelphia Sustainability Awards 2008 Nominations)

GreenPlan Philadelphia establishes goals for environment, social equity/quality of life economic enhancement and innovations. It creates a twenty-year vision and identifies intermediate steps required to achieve those goals. Most importantly, it identified and involved the key players required to achieve institutional changes necessary to change how things get done. (GreenPlan Philadelphia 2010)

2007 saw the production of a Local Action Plan for Climate Change by the City's Sustainability Working Group. Mayor Nutter established the Office of Sustainability shortly after his 2008 inauguration. By the Spring of 2009 a sustainability plan titled GreenWorks Philadelphia was released. GreenWorks identifies goals for energy, environment, equity, economy, and engagement. A total of fifteen (15) targets are identified, three (3) deal directly with key elements of green infrastructure. All three of the green infrastructure targets are grouped under the equity goal.

- Target eight (8) deals with stormwater management and states, "Manage stormwater to meet Federal Standards … GreenWorks Philadelphia recommends that the natural links between land and water be reconnected and that green infrastructure – trees, vegetation and soil – become the City's preferred stormwater management system."
- Target nine (9) addresses park access. "Provide park and recreation resources within 10 minutes of seventy-five (75) percent of residents."
- Target eleven (11) increase tree coverage toward thirty (30) percent in all neighborhoods by 2035 (GreenWorks Philly's Sustainability Plan 2009)

In 2008 The Trust for Public Land published a report documenting the economic impact of Philadelphia's park system. It estimated that the system had a total impact of nearly $2 billion on the City's economy in 2007. Factors included:

- $23 million additional revenue in direct tax receipts due to increases in property value and tourism taxes;
- $16 million savings in stormwater management, air pollution, and community cohesion;
- $1,145.7 million savings for citizens in direct use and health; and
- $729 million in wealth increase for citizens (property values and tourism profits).

The report noted that approximately 60% of the City is served by combined sewer systems and that the vegetated areas in parks significantly reduce stormwater runoff into those systems. It elaborates that this number maybe conservative because it only compares the amount of annual rainfall and annual operating costs of the systems. Because the Environmental Protection Agency is requiring more aggressive clean water standards the value of stormwater management in the park system maybe closer to $500 million. They also note that valuation methodologies for park systems have received little attention and are not robust. "Determining the economic value of a city park system is a science still in its infancy." (Trust for Public Land 2008)

The Philadelphia Water Department (PWD), included a "triple bottom line analysis" for the City's watersheds in its Combined Sewer Overflow Long Term Control Plan Update in 2009. It

compares the costs and benefits of addressing EPA mandates for water management through the creation of 30' storage tunnels or reducing the system loads through green infrastructure over a 40 year time frame. This study defines green stormwater infrastructure as

> "… a range of soil-water-plant systems that intercept stormwater, infiltrate a fraction of it into the ground, evaporate a portion of it into the air, and in some cases release a portion of it slowly back into the sewer system. … PWD's definition of green infrastructure also includes restorations of physical habitats in stream channels, along stream corridors, and on riverfronts. … Restoration of stream habitats and riverfronts can also be combined with efforts to improve public access and amenities along the water corridors."

A basic concept for this analysis is the "greened area," defined as the percentage of an area served by green infrastructure. The green infrastructure/storage tunnel analysis includes valuations of:

- Increased recreational opportunities
- Increased property values
- Reduction in heat stress mortality
- Water quality/aquatic habitat enhancement
- Wetland services
- Social cost avoidance due to the creation of green jobs
- Air quality improvements due to trees
- Energy savings/usage
- Reduced/increased damage from SO_2 and NO_x emissions
- Reduced/increased damage from CO_2 emissions
- Disruption costs from construction and maintenance (vehicle delay)

The present value cost/benefit comparison cumulative 2009-2049 estimates in 2009 dollars found positive values of $2,846.4 million for of treating 50% of impervious runoff through green infrastructure and $122 million for the 30' tunnel option. The study notes that green infrastructure provides community benefits beyond improvements in water quality. Traditional infrastructure has two main drawbacks: first it does not provide recreational and property value enhancements, and second, it may not address the root causes of impaired urban streams such as modified flow patterns and habitat degradation.
(Triple Bottom Line Analysis 2009)

Parks management will need additional funding to manage acres devoted to stormwater infiltration. The costs avoided by redirecting water from the combined sewer system and other government services provided by an integrated park system need to be captured and used for the management of a dynamic system. The Office of Watershed's "Triple Bottom Line" cost/benefit analysis could provide the foundation for such utility fees.

Policy

The City has adopted a policy of leveraging its existing assets. The Mayor's Sustainability Office provides a framework that encourages departments to work together. The PWD acknowledgement of benefits inherent in natural water systems that reduce flow into their

combined sewer system through their "triple bottom line analysis" provides an additional foundation for cross-departmental discussion. The system of natural lands managed by Fairmount Park is a resource that is being leveraged to address some the City's recreation, social, economic, and environmental needs. The City has initiated multiple programs designed to capture the first inch of rainfall on-site. These include Green Streets, tree planting initiatives, stormwater fees based upon impervious surface, green roof credits, and downspout disconnect programs. In addition, it has set clear goals for park access and canopy cover.

Outreach

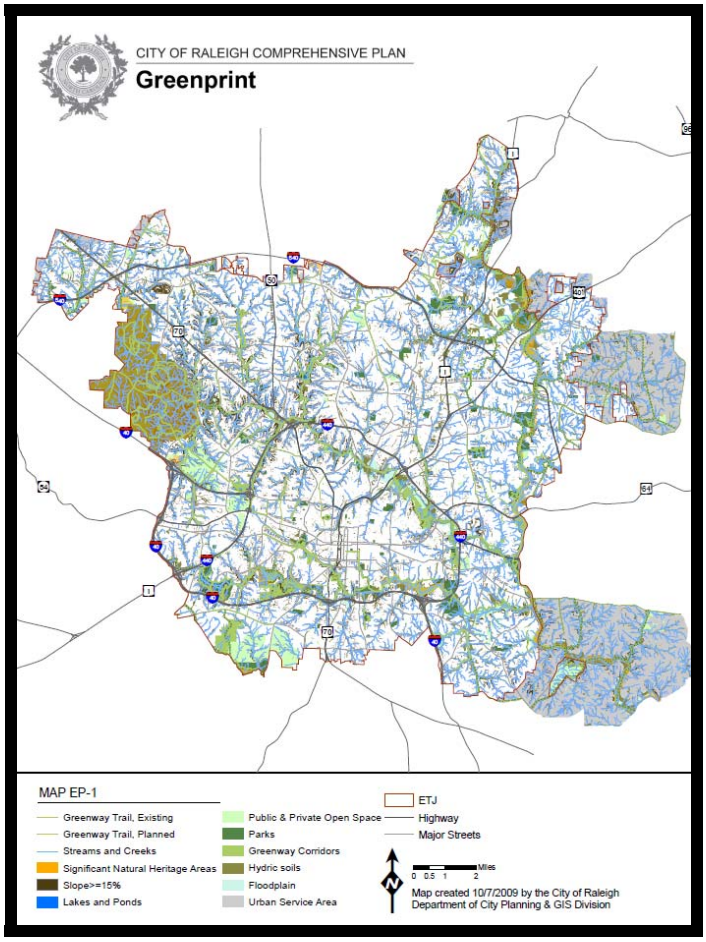
Outreach initiatives have taken place both internally between departments and as public discussions. Regular meetings within the Sustainability Working Group created a platform for City staff discussions. In addition, local foundations and supporting organizations have provided funding for research and recommendations. These have resulted in a broad understanding of the issues and opportunities inherent in green infrastructure.

Summary

Philadelphia has a rich history of leveraging water management and parks. It's desire to be the "greenest city in the country" has created a foundation for re-establishing that tradition. Other communities can learn much from its "triple bottom line analysis" and the vision of its GreenPlan. However, without revenue streams that support leveraged benefits in a balanced fashion, it is likely that considerations for which funding is available will soon dominate the green infrastructure system. Suggestions that could help balance parks and recreation considerations with water management include:

- Systematic park and recreation reviews as a required part of development concept approval
- Evaluation of walk/bike routes to destinations within .5 mile of development projects
- Design standards that create space for mature canopy trees, particularly along streets
- Establishment of an "area of interest map" used to flag projects that could be leveraged for greenways, the more robust protection of sensitive lands, recreation, and park access
- Use of a services/cost avoidance metric to establish an infrastructure utility fee supporting park planning, acquisition, and management

Raleigh, NC



City of Raleigh – Comprehensive Plan Green Print map

Established in 1792, Raleigh, NC had a 2000 census population of 276,093 and covered 143 square miles. It is located in the north central part of North Carolina on the fall line.

Raleigh is credited with initiating one of this country's earliest comprehensive greenway systems by Charles Little, in his book Greenways for America. (Little 1991) The City has many streams. As the City experienced rapid growth, its leaders became concerned about development that would be vulnerable to flooding and initiated an ambitious greenways program. The Parks Department embraced the concept and used the greenway corridors to establish the skeleton of the park system. The City's comprehensive plan, adopted in 2009, calls for the creation of a green infrastructure plan with input from multiple departments.

Planning

In a 1969 open space plan, "Raleigh, The Park With a City In It," the City established the concept of a greenway system based on the protection of drainage systems and natural areas. (Raleigh

Parks Plan 2004) Community leaders realized that such a system also provided an opportunity for outdoor recreation areas and both goals became ingrained elements in parks planning. The Greenway Concept was developed in a series of initiatives beginning in the early 1970s. The Capital Area Greenway Plan, adopted by the Raleigh City Council in 1976, identified 268 miles of greenway corridors. (Dick Bailey interview) It defines greenways as, "a corridor of protected open space that is managed for conservation, recreation and connectivity." In the Raleigh vision, greenways provide environmental, economic, and quality of life benefits. (Lebsock power point)

In 2009, the City adopted its current comprehensive plan, the Raleigh Comprehensive Plan 2030 (2030 RCP). The Land Use plan has two classifications for areas supporting outdoor recreation.

1) Public parks and open space- defined as permanent open space intended for recreation or conservation in perpetuity.
2) Private open space includes open space that is privately owned and maintained, it is expected that these lands will remain as open space through 2030.

The environmental protection section calls for the creation of a green infrastructure plan focusing upon natural resources and the establishment of a green infrastructure team that will include the
City's Sustainability Coordinator, the City Manager's office, Planning, Parks and Recreation, Public Utilities, and Public Works Departments. The team is charged with developing an action plan for the implementation of day-to-day policies for the implementation of the green infrastructure plan. (2030 RCPThe water quality section recommends expansion of the greenway concept to include "receiving lands'" with the potential to absorb overflows resulting from major storm surges. In addition, the comprehensive plan recommends maintaining at least fifty percent tree canopy coverage from shade trees within sidewalk panting strips. The importance of environmental education is stressed.

Regulations

Along all designated streams the City requires a 100' setback from the top of bank or the entire delineated floodplain on both sides of stream center lines, whichever distance is greater. Along the Neuse River this setback is expanded to 150' on both sides of the river or the entire flood plain. Other tools used to implement the City's greenway plans include the subdivision ordinance, development impact fees, and fee simple acquisition.

Funding

Funding has come from bond programs that have been passed every few years since 1981. As of 2007 the park system contained 8,990 acres, nearly 10 percent of the City's land area. Just over a third of that land is in greenway corridors. (2030 RCP)

A scan of the Stormwater Utility webpage shows a list of traditional projects- pipes, culverts, dams, and stream bank restorations. The Public Utilities element of the City's 2030 Comprehensive Plan devotes a paragraph to Greenprint Raleigh, an underlying theme for the comprehensive plan. It notes that stormwater policies impact water quality and the importance

of infiltration upon aquifers. (2030 RCP) It states that the Stormwater Division has developed 15 drainage basin studies. Although the connection between stormwater and water quality is noted, there is no mention of recreational uses. Neither acquisition opportunities within a greenway system or the use of stormwater utility funds to leverage synergistic opportunities with outdoor recreation are addressed.

Organizational Structure

The Parks and Public Works Departments appear to work independently. The goals and recommendations articulated in the 2030 Raleigh Comprehensive Plan indicate that the Planning Department considers outdoor recreation and water management to be critical community services and is working to establish venues for coordinated efforts.

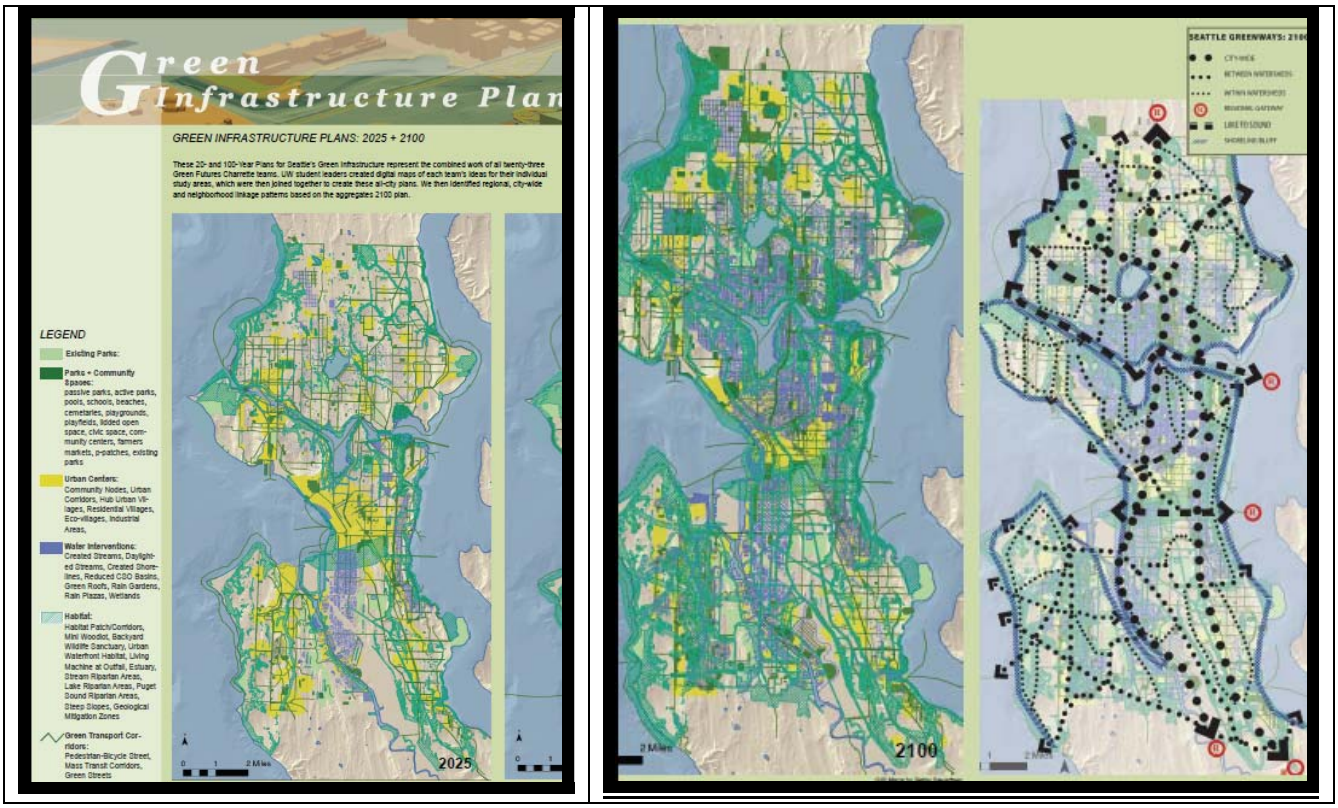
Outreach

Raleigh's extensive greenway trail system puts many of its residents in contact with the outdoors. However, more opportunities for environmental education are stressed in the City's comprehensive plan. Permanente interpretation facilities in parks, expanded master gardener programs, and outreach to the public school system are all cited as possible ways to reach a broader population. (2030 RCP) The stormwater utility web site also notes the need for environmental education initiatives.

Summary

Raleigh focuses on its streams to create a framework of greenway corridors and this has become an important skeleton for its park system. As managed by the Parks Department these corridors provide many community services including water management, climate mitigation, air quality, habitat protection, environmental education, active transportation, and outdoor recreation. In a time of reduced governmental resources, staffs responsible for water management and recreation need to find ways to leverage resources to meet community needs. The 2030 Raleigh Comprehensive Plan's recommendation for a cross cutting approach to green infrastructure should help facilitate the potential for planning, acquisition, development, programming, and maintenance of the City's green infrastructure system.

Seattle-King County, WA



Seattle's Green Infrastructure Plan from Open Space Seattle 2100

Located in the northwest corner of Washington State, Seattle has enjoyed access to the Pacific Ocean through Puget Sound. In 2000 it had a population of 563,374 and a encompassed a land area of 92 square miles.

Seattle considers itself "built-out." Its boundaries are constrained by natural topography and its population is growing. A coalition of academic, advocacy, and government groups are looking for new ways to respond to these challenges. The Seattle Public Utilities group has promoted stormwater infiltration on both public and private properties. The Parks Department Strategic Plan notes its mission to protect critical resources. Non-profit groups are active in promoting a broad spectrum of green infrastructure projects. The University of Washington has a Green Futures Institute that takes an active interest in the City by using it as a living laboratory for its students.

Seattle Public Utilities (SPU) is responsible for meeting water quality requirements. It has implemented a combination of capital demonstration projects, incentives targeting private property owners, training for industry professionals, and public education. The Seattle Green Factor requires 30 percent of a parcel be vegetated, but allows practices such as green roofs, permeable paving and green walls to contribute toward the calculation. (EPA 2010)

The City evaluates projects on a Triple Bottom Line approach that includes the project impact and opportunities relating to social, economic, and environmental services. However, it is difficult to evaluate qualitative benefits. The evaluation of the psychological impact of a tree or sidewalks that allow people to walk in groups lack preciseness, but there are antidotal stories of increased walking along streets that have been retrofitted with bio-swales. (Tracy Tackett interview) Hedonic studies have shown that properties near quality green spaces can sale for significant premiums. (Crompton 2007) There is increasing evidence that near-by access to green space is more important for disadvantaged groups than for those with the resources to travel. (Maas 2009) The climate mitigation effects of green streets are acknowledged, but also difficult to quantify in a way that is understood in a business analysis.

In their role as manager of NPDES compliance SPU has focused on decreasing pollution discharges from combined sewer systems. Their strategy includes significantly reducing flow into the combined sewer system and improving the quality of water flowing into water bodies. (Tracy Tackett interview) They have proceeded by sponsoring catalytic demonstration projects. An important part of the Seattle approach is the award winning “Green Streets” Program. The city also has a provision for a fee in-lieu that allows developers to contribute to stream system improvements instead of constructing on-site storage vaults. Seattle Public Utilities requires that on site detention be designed as a community amenity. The City’s Natural Drainage System (NDS) approach to street design collects runoff that is filtered through vegetated areas located within the public right of way. (EPA 2010)

Seattle’s High Point development incorporates a combination of approaches from disconnected down spouts to bio-swales along street rights-of-way. The award-winning project includes a broad commons, community garden, a playground area, walkways, and an expansive commons area.

Planning

In 2006 the University of Washington, Green Futures Institute coordinated a 2-day charrette to establish a vision for Seattle’s green infrastructure. Nancy Rottle, a co-director of Open Space Seattle 2100 from the University of Washington, describes the initiative ”as a collaborative design and planning process established to create a context where students, professionals, civic leaders and the public envisaged new urban form idioms and formulated a cohesive community vision for Seattle’s comprehensive green infrastructure network.” (Rottle 2010) The resulting plan articulated in Open Space Seattle envisions:

"… integrated, connected 'green infrastructure' that supports urban functions without damaging the atmosphere or water: bikeways, green freeways, natural drainage filtration, and tree canopy are all part of that system. … density and community, by focusing development into urban nodes that contain civic spaces, local identities, walkable amenities and abundant public transit. …public and private ecological open spaces that restore ecological functions and promote aquatic and terrestrial biodiversity. Growing healthy, connected urban forests, restoring streams, and shorelines, and setting aside earthquake and hazard zones as greenbelts are examples. … democratic access to open space, so all people, in all neighborhoods, can reap the benefits of a multi-faceted open space system." (Open Space Seattle 2100)

A great deal of groundwork went into the Open Space Seattle charrette. Over 50 organizations and agencies represented by more than 100 individuals had worked to establish goals and guiding principles. They also reviewed research and products. University of Washington students gathered and annotated over 100 relevant plans and created interactive maps. The charrette drew over 300 people who were divided into 23 teams.
Mapping included:

- Parks and Community Spaces
- Urban Centers
- Water interventions (daylighted streams, created shorelines, reduced CSO basins, green roofs, rain gardens, rain plazas, and wetlands)
- Habitat (riparian areas, steep slopes, geological mitigation zones)
- Green Transportation Corridors

Key recommendations from these efforts are:

1. Create a Green Infrastructure Task Force
2. Adoption and implementation should be institutionalized within the city and participating groups.
3. Fund the vision by 1.Make open space part of every project and 2. Pass a Green Infrastructure levy.
   (Open Space Seattle 2100)

Currently Seattle Parks and Recreation owns approximately 11% of the City's total land area, more than 6,200 acres of parkland located in over 400 parks and open areas. Goal one of the Parks Strategic Action Plan is to sustain the City's parklands and plan effectively for their future. The plan notes: "We are committed to the preservation of parkland and open space to conserve the community's natural legacy and contribute to the ecological health of Seattle. We will plan for the future open space needs of the City; increase restoration of the urban forest and open space, with a focus on preservation through community partnerships; evaluate opportunities to build on the Olmsted legacy; and seek ways to revitalize Center City parks.
(Seattle Parks and Recreation Strategic Action Plan: 2009-2013)

In 2008 nearly 59% of Seattle voters supported a $146 Million Parks and Green Spaces Levy to be assessed for six years, 2009-2014. The levy is to leverage green infrastructure, support

boulevards that include bio-swales, and acquire parks in underserved urban villages. Distribution and access to public parks are important evaluation criteria. (Chip Nevins interview)

Summary
In Seattle a broad coalition came together to build on the City's many existing green infrastructure initiatives. The University of Washington developed a process to establish a clear vision and spatial template for institutionalizing the synergies inherent in the green infrastructure concept. Using "triple bottom line analysis" to guide projects and programs provides a tool for systematically asking the questions that leverage opportunities.

Case Study Findings

Each of the communities studied has taken steps to establish approaches to water management that also leverage other community services. Lenexa and Raleigh have focused on opportunities to mitigate flooding. Seattle and Philadelphia have focused on water quality and ways to reduce the storage demands of combined sewer systems.

An articulated vision
Without a clear direction of community desires it is difficult to sustain collaboration between diverse interests. A community statement in its comprehensive or long-range plan facilitates the consistent direction required for a green infrastructure program to be successful. It is critical that green infrastructure be defined explicitly to include it's multiple leverage points. A simple goal statement or definition clarifying important aspects of green infrastructure establishes that agencies need to work together. Without that vision, it is much too easy for stressed departments and staff to exclude opportunities not seen as their responsibility. To reach its full potential green infrastructure should include:

- Active transportation in the form of sidewalks and trails
- Canopy trees and the space required to support mature root systems
- Urban Forests
- Urban agriculture
- Wildlife habitat
- Climate mitigation
- Air quality
- Stormwater management in corridors, regional lakes, and on-site capture of low level storms each designed to be an attractive feature
- Water quality measures that encourages the filtering of pollutants that accumulate in urban runoff before that runoff reaches streams and lakes
- Outdoor recreation
- Highly visible public access to the places that make every community unique

- Environmental education programs
- Walkable access to outdoor spaces throughout the community

Inventories and Mapping
A full inventory of sensitive lands mapped with desirable buffers allows projects to be flagged for appropriate reviews, design considerations, and incentives.

Funding
Funding is a critical factor in the creation and management of public infrastructures. Without it, opportunities are missed and considerations that have dedicated funding streams begin to exclude those with few resources. Seattle and Raleigh have histories of passing supportive bond referendums. Lenexa uses a combination of sales tax, stormwater utility, and impact fees. Philadelphia is restructuring its water fees and development regulations.

Organizational Structure
Internal departments need to share a broad vision that encourages the leveraging of opportunities. In Lenexa, the Public Works Department used its sales tax funding to purchase land that was leveraged for a regional park. In Philadelphia, Fairmount Park is leveraging its extensive holding of natural lands and meadows to reduce the volume of stormwater flowing into the City's combined sewer system.

Supportive Regulations
Requirements for on-site retention of low-level storms was evident in all of the communities studied. These were reinforced with incentives and education programs.

Regional detention of high volume storms presents opportunities for lakes and greenway development if appropriate buffers are established as part of the project concept. Lenexa projected the impact of its built out condition and established the needed infrastructure to manage that condition. It acquired appropriate lands using revenue from its "Rain-To-Recreation" sales tax. Infrastructure is constructed as needed using funds from development fees. Maintenance is addressed by its stormwater utility fee.

Outreach
Outreach using multiple approaches and at different levels is needed to promote green infrastructure concepts. Internal understanding within a government is required to leverage limited resources, this reaches from elected officials to maintenance staff. Repeated meetings, presentations, workshops, and knowledgeable staff available to respond to repeated questions are required. Stakeholder buy-in is critical, Lenexa worked very hard with its development community to establish an understanding that regional detention lakes and greenway corridors along streams could add value to their projects and mechanisms that funded their creation were in their best interests. Seattle focused on highly publicized demonstration project to make the

case for their green streets program. In Philadelphia multiple plans and reports reinforce each other and are supported by the Mayor's Office. Raleigh has leveraged its popular greenway system. Public education and interpretive programs are also critically important.

Case Study Conclusions

Given the strong support for infrastructure that meets multiple community goals, it is surprising that local governments have not found more robust ways to establish and manage their public infrastructures. Seattle and Philadelphia's triple bottom line project evaluation is a promising technique for encouraging decisions that promote holistic community goals. In these case studies, water management, from either the quantity or the quality aspects, has been the primary program driver. This is largely due to federal regulatory requirements that have forced local governments to act or face fines. Parks, trails, street trees and other social goals do not have equivalent regulatory mandates. Community support for these "softer" services is linked to economic and quality of life justifications.

Section 3: Overall Conclusions

Green Infrastructure is a new model for local government service delivery. It breaks silos that have led to the fragmented management of natural systems and the public realm. It provides opportunities and savings inherent in the synergistic planning and management of community resources. Unfortunately, there are significant barriers. Perhaps the most significant is organizational structures that lead department heads to ignore leverage opportunities that are not part of their core mission. The communities profiled in these case studies are working to find ways to deliver their services more effectively.

A green infrastructure concept that understands natural systems within an urban context has the potential to provide for both capital projects and the often neglected, need for consistent, pro-active management. In many communities, parks, sidewalks, and street trees are touted as critical community infrastructure, yet the resources required to support them are regularly cut from overburdened general funds. When asked to vote on parks and conservation measures American voters usually pass them. Even in the tough economy of 2010, 84 percent of such measures passed. (TPL Land Vote 2010) But, without dedicated funding for consistent management this infrastructure falls into disrepair. The communities profiled have taken steps to bridge conceptual and structural silos focusing on a single aspect of local government service. They link stormwater and water quality management to trees, trails, parks and recreation.

It is suggested that national models and techniques supporting multiple community services be established. A task force of experts that includes: stormwater, water quality, active transportation, park access, urban forestry, eco-systems, and air quality should be convened to evaluate opportunities to leverage local resources in the provision of public services. Some of the ideas that might be investigated include:

1. Develop of comprehensive inventories of targeted lands that include appropriate buffers
2. Creation of urban greenways that are accessible from neighborhoods- the relationship of street patterns and subdivision codes
3. Land acquisition for regional detention facilities that serve as centerpieces for larger parks. Planning that anticipate this multiple use.
4. Creation of greenways along streams that include buffers supporting access and trails.
5. Promotion of neighborhood detention that supports outdoor play areas
6. Green Streets
7. Sidewalks that function as outdoor play space
8. Active transportation systems (walking and biking)
9. Creation of space to support mature canopy trees
10. Model development codes that promote urban green infrastructure
11. Investigation of timing issues that make it difficult to coordinate projects

Models that leverage cross cutting community goals are still weak. Sustainability programs are identifying opportunities. Triple bottom line analysis is a tool to bring such issues into the discussion. However, supportive organizational structures and long term revenue streams are needed for significant implementation. A possible approach would be the creation of a Green Infrastructure Utility. Such a utility would be structured to unite a broad range of urban environmental and social infrastructures. A Green Infrastructure Utility based upon a vision that leverages multiple community services could establish a necessary revenue stream for infrastructure management. By basing fees upon the cost avoidance inherent in protecting flood plains, encouraging ground water infiltration, energy savings from urban forests, and supporting healthy lifestyles, such a utility could provide the dedicated funding for public infrastructure missing in many local government budgets.

The collective experiences of communities across the country demonstrate opportunities to leverage their resources using green infrastructure.

References

2030 RCP- Raleigh Comprehensive Plan 2030. adopted November 1, 2009; http://www.raleighnc.gov/search/content/PlanLongRange/Articles/2030ComprehensivePlan.html

Akbari, H. 2005. Energy Saving Potentials and Air Quality Benefits of Urban Heat Island Mitigation (PDF) (19 pp, 251K). Lawrence Berkeley National Laboratory. http://www.osti.gov/bridge/purl.cover.jsp?purl=/860475-UlHWIq/

Arendt, R (1996). Conservation Design for Subdivisions. Washington, DC: Island Press.

Banerjee, T (2001). "The Future of Public Space: Beyond Invented Streets and Reinvented Places." *Journal of the American Planning Association 67*(Winter), 9.

Beezhold, MICHAEL T. and Donald Baker (2006). "Rain to Recreation: Making the Case for a Stormwater Capital Recovery Fee." Water Environment Federation Technical Exhibition and Conference; accessed on http://www.environmental-expert.com/Files%5C5306%5Carticles%5C11741%5C299.pdf accessed 10-2010

Behavioral Risk Factor Surveillance System. (2007). http://www.cdc.gov/brfss/. Accessed April 20, 2009.

Benedict, MA, McMahon, ET (2006). Green Infrastructure: Linking Landscapes and Communities; Washington, DC, Island Press

Bradley, Jennifer and Bruce Katz; "What the Delegates Can Learn From Denver." The Brookings Institution. http://www.brookings.edu/opinions/2008/0825_intermountain_west_katz.aspx; accessed May 31, 2010

Bridge to the Future- Fairmount Park Strategic Plan. http://www.fairmountpark.org/strategicplan.asp accessed 12-2010

Centers for Disease Control and Prevention. State Indicator Report on Physical Activity (2010). Atlanta, GA: U.S. Department of Health and Human Services, 2010.

Crompton, John (2007). "The Impact of Parks and Open Spaces on Property Taxes," TPL. The Economic Benefits of Land Conservation

Crompton, John (2007). "The Role of the Proximate Principle in the Emergence of Urban Parks in the United Kingdom and in the United States," Leisure Studies Vol. 26, No 2, 213-234, April 2007

Debo, Thomas N; Reese, Andrew J (2003). Municipal Storm Water Management; Boca Raton, FL, Lewis Publishers

Environmental and policy approaches to increase physical activity: community-scale urban design land use policies & practices In: Services TFoCP, ed. *The Guide to Community Preventive Services.* Vol July 2006. Increasing Physical Activity: A Report on Recommendations of the Task Force on Community Preventive Services Oct 26, 2001.

EPA- Heat Island Impacts; http://www.epa.gov/hiri/impacts/index.htm, accessed 12-10-2010

EPA Office of Wetlands, Oceans, and Watersheds (2010). "Green Infrastructure Case Studies: Municipal Policies for Managing Stormwater with Green Infrastructure," EPA-841-F-10-004; August 2010

Faber, Taylor; Kuo, FE (2009). "Children with attention deficits concentrate better after a walk in the park." Jr of Attention Disorders; 12: 402-409

Faber, Taylor; Kuo, FE; Sullivan, William C (2001). "Coping with ADD: the surprising connection to green play settings." Environment and Behavior, 33 (1): 54-77

Farr, Douglas (2008). Sustainable Urbanism: Design with Nature; Hoboken, NJ; John Wiley & Sons

Fisher, I (1986). *Frederick Law Olmsted and the City Planning Movement in the United States* (Vol. 15). Ann Arbor: UMI Research Press

Flink, Charles A, Searns, Robert M.; Schwarz, Loring LaB (editor) (1993). Greenways: A Guide to Planning Design and Development; Washington, DC; Island Press

Flournoy, William, President Tri-Cities Greenways; letter to Mayor Charles Meeker, August 28, 2009

Georgia's Community Green Space Program: A Report of the Community Green Space Advisory Committee Dec 1999

Giarrousso, T. (2006). *Park Accessibility: Examining Park Accessibility for Selected City of Atlanta Parks Using G.I.S.* Atlanta, GA: Georgia Institute of Technology

Gill, SE, Handley, JF, Ennos, AR, Paluleit (2007). "Adapting cities for climate change: the role of green infrastructure." Built Environment 33 (1): 115-133

Green City:Clean Waters- The City of Philadelphia's Program for Combined Sewer Overflow Control, A Long Term Control Plan Update (Sept 2009). http://www.phillywatersheds.org/what_were_doing/documents_and_data/cso_long_term_control_plan/ accessed 11-12-2010

GreenPlan Philadelphia (2010). Prepared for the City of Philadelphia by Wallace Roberts and Todd

GreenWorks Philly's Sustainability Plan (2009). http://www.phila.gov/green/greenworks/index.html accessed 11-12-2010

Grumbles, Benjamin H (2007). AAUEPA. "Using Green Infrastructure to Protect Water Quality in Stormwater, CSO, Nonpoint Source and other Water Programs."

History of Fairmount Park. http://www.fairmountparkhistoricsites.org/fairmount_park_history.html accessed 11-2010

Jim, CY (2004). Green-space preservation and allocation for sustainable greening of compact cities. *Cities, Vol. 21, No. 4*, p. 311–320.

Kaplan, R (2004). Open Space Communities. *Journal of the American Planning Association, 70*(Summer), 300 -312.

Kaplan, R, Kaplan, S, & Ryan, RL (1998). With People in Mind: Design and Management of Everyday Nature. Washington, DC: Island Press.

Kuo, FE; Sullivan, William C (2001 a). "Aggression and violence in the inner city: Impacts of environment via mental fatigue." Environment and Behavior, 33 (4): 543-571

Kuo, FE; Sullivan, William C (2001 b). "Environment and crime in the inner city: Does vegetation reduce crime?" Environment and Behavior, 33 (3): 343-367

Kurn, D, S Bretz, B Huang, and H Akbari (1994). The Potential for Reducing Urban Air Temperatures and Energy Consumption through Vegetative Cooling (PDF) (31 pp, 1.76MB). ACEEE Summer Study on Energy Efficiency in Buildings, American Council for an Energy Efficient Economy. Pacific Grove, California.

Kwik Facts - Seattle City Clerk; http://www.cityofseattle.net/leg/clerk/kwikfact.htm#area accessed Nov 2010

Lancaster RA (1983). Recreation, Park, and Open Space Standards and Guidelines. Alexandria, VA: National Recreation and Park Association

Lebsock, Victor, City of Raleigh Greenway Planner; Raleigh; Capital Area Greenway power point presentation; http://www.raleighnc.gov/search/content/PRecDesignDevelop/Articles/CapitalAreaGreenwayTrailSystem.html; accessed 11-10-2010

LeisureVision (2007). "City of Atlanta Community Attitude and Interest Citizen Survey Findings Report." Atlanta, GA

Lenexa, KS, Rain To Recreation program web site. http://www.raintorecreation.org/who_we_are.html, Accessed November 2010

Little, Charles E (1995). Greenways for America. Baltimore, Maryland: The John Hopkins University Press

Louv, R (2005). *Last Child in the Woods: Saving Our Children from Nature-Deficit Disorder*. Chapel Hill, NC: Algonquin Books of Chapel Hill

Maas, J; et al. (2009). "Morbidity is related to green living environment." Journal of Epidemiol Community Health63: 967-973

McHarg, I (1965). Design with Nature. New York: John Wiley & Sons.

McPherson, E, J Muchnick (2005 b). "Effects of street tree shade on asphalt concrete pavement performance." Jr of Arboriculture 31 (6): 303-310

McPherson, EG, J R Simpson, PJ Peper, SE Maco, and Q Xiao (2005 a). Municipal forest benefits and costs in five US cities. Journal of Forestry 103(8): 411–416

Open Space Seattle 2100; http://open2100.org/ accessed Nov 10, 2010

Philadelphia Sustainability Awards 2008 Nominations - GreenPlan Philadelphia. http://www.philadelphiasustainabilityawards.org/node/337 accessed 12-2010

Rain To Recreation- Project Summary (2007) http://www.nlc.org/ASSETS/D01F68A2D24B47779ED714263B4CDEDE/Lenexa%20for%20Website.as.pdf, Accessed November 2010, National League of Cities- 2007 Awards for Municipal Excellence.

Raleigh Parks Plan Adopted 2004; http://www.raleighnc.gov/portal/portal/cor/search/SearchBoxV14Window?action=e&windowstate=normal&mode=view

Rottle, Nancy D (2010). "Integrating Urban Green Infrastructure through Collaborative Visioning." presentation New Partners for Smart Growth Feb 5, 2010; http://www.newpartners.org/2010/docs/presentations/friday/np10_rottle.pdf accessed Nov 2010

Seattle Parks and Recreation Strategic Action Plan: 2009-2013. http://www.cityofseattle.net/parks/Publications/StrategicActionPlan.pdf accessed Nov 2010

Seattle Parks Strategic Action Plan 2009-2013; Adopted 2008; http://www.seattle.gov/parks/Publications/StrategicActionPlan.pdf; accessed Nov 2010

Sherer, PM (2006). *The Benefits of Parks: Why America needs More City Parks and Open Space.* Washington, DC: Trust for Public Land

Stone, B (2007). Presentations on Urban Heat Islands; Atlanta, GA

Triple Bottom Line Analysis (updated Oct 1, 2009). Vol 2 - Supplemental Documents of Green City:Clean Waters- The City of Philadelphia's Program for Combined Sewer Overflow Control, A Long Term Control Plan Update. Sept 2009. http://www.phillywatersheds.org/what_were_doing/documents_and_data/cso_long_term_control_plan/ accessed 11-12-2010

Trust for Public Land (2008). How Much Value Does the City of Philadelphia Receive from its Park and Recreation System? http://www.tpl.org/content_documents/PhilaParkValueReport.pdf accessed 12-2010

Trust for Public Land: Land Vote (2010). http://www.tpl.org/tier2_kad.cfm?folder_id=2386; accessed 11-10-2010

Tzoulas, K, et al (2007). "Promoting ecosystem and human health in urban areas using green infrastructure: A literature review." Landscape and Urban Planning 81:167-178

US Census
http://quickfacts.census.gov/qfd/states/42/4260000.html accessed December 2010

U. S. National Park Service (2010). http://www.nps.gov/aboutus/mission.htm. Accessed April 21, 2010.

Weber T, A Sloan, J Wolf (2006). Maryland's Green Infrastructure Assessment: development of a comprehensive approach to land conservation." Landscape and Urban Planning 77: 94-110

Wolf, Katherine (2003). "Social aspects of urban forestry: Public responses to the urban forest in inner-city business districts." Jr of Arboriculture 29 (3): 17-126

Interviews

My thanks to these individuals who took time to discuss their community's green infrastructure initiatives. Your direction and insights are deeply appreciated.

Dick	Bailey	Raleigh Parks and Recreation	Raleigh, NC
Mark	Focht	Executive Director Fairmount Park - the city's park system	Philadelphia, PA
Katherine	Gajewski	Director Mayor's Office Of Sustainability	Philadelphia, PA
Nikki	Guillot (Geo)	Stormwater Specialist	Lenexa, Ks
Victor	Lebsock	Greenway Planner	Raleigh, NC
Johnny	Medlin	Parks and Open Space Division Director, Dept of Public Works	Eugene, Or
Frana	Milan	King County Parks Program, Business Development	King County, WA
Chip	Nevins	Acquisition Planner, Seattle Parks and Recreation	Seattle, WA
John	Phillips	King Co Natural Resources and Parks, Wastewater Division	King County, Wa
Gary	Ristow	Parks and Recreation	Lenexa, Ks
Tracy	Tackett	Green Stormwater Infrastructure Program Manager, Seattle Public Utilities	Seattle, WA
Laura	Turnbull	Planner – Community Development Strategic Planning	Lenexa, Ks
Caroline	Weiss	Principle Planner	Eugene, Or

Appendix A- Sample Interview Questions

Goals and Metrics-

1. Does the jurisdiction have goals for % of land area to be protected?
2. Does the jurisdiction have goals for % of sensitive land to be protected?
3. Does the jurisdiction have goals for acres of public access land per population?
4. Does the jurisdiction have goals for access to public parkland?
5. How are these goals measured?
6. What are the goals the community has established?
7. Is there a green infrastructure vision articulated in the community's comprehensive plan?

Implementation-

1. Is there an inventory of sensitive lands?
2. How are they defined?
3. How is land acquisition funded?
4. Do review processes allow meaningful input and project modification to achieve secondary benefits?

Techniques-

1. Are techniques that support multi functional space used? What are they?
2. Is there a land-based utility that supports the leveraged use of land for secondary benefits?
3. Is there dedicated staff assigned to leveraging synergistic opportunities?
4. Is there a transfer of open space[5] program?

Open Ended Questions-

1. How did the program get started?
2. What issues had to be addressed?
3. Who was the "champion?"
4. Who is involved?
5. What is the relationship/role of other programs?
6. How are projects coordinated?
7. Are development incentives in place? Anticipated?
8. What makes it work?
9. What were/are the biggest barriers/challenges?
10. What has been accomplished?
11. Have there been unexpected results?
12. What would make the programs stronger?

[5] Transfer of open space refers to a technique of allowing developers to contribute funds to an account dedicated to the acquisition of open space in lieu of fully meeting on site open space requirements.

Appendix B – Case Study Overviews

Lenexa, KS

2000 Population: 40,238
Established: 1907
Land area: 34.4 square miles
Location: 12 miles southwest of downtown Kansas City, KS
Comprehensive Planning:

-1996 Vision 2020
-2007 Vision 2030

Inventory mapping:

-Lenexa Stream Inventory (establishes stream order based on stream quality)
-Parks and trails map
-Watershed Management Plan

Regulations:

-Stream setbacks that include the 100 year flood plain plus 25 feet in priority areas
-Best Management Practices Manual- promote on-site treatment of low-level storms
-Unified Development Code supports on-site retention of low-level storms
-Transfer of development rights

Funding:

-General Fund (2000 to 2006 the City's general fund provided funds for the program)
-Sales tax (2000- 2010)
- Stormwater Utility (approved in 2000)
-Systems Development Charge (impact fee)
- Leveraged grants and program funding from outside sources

Implementation:

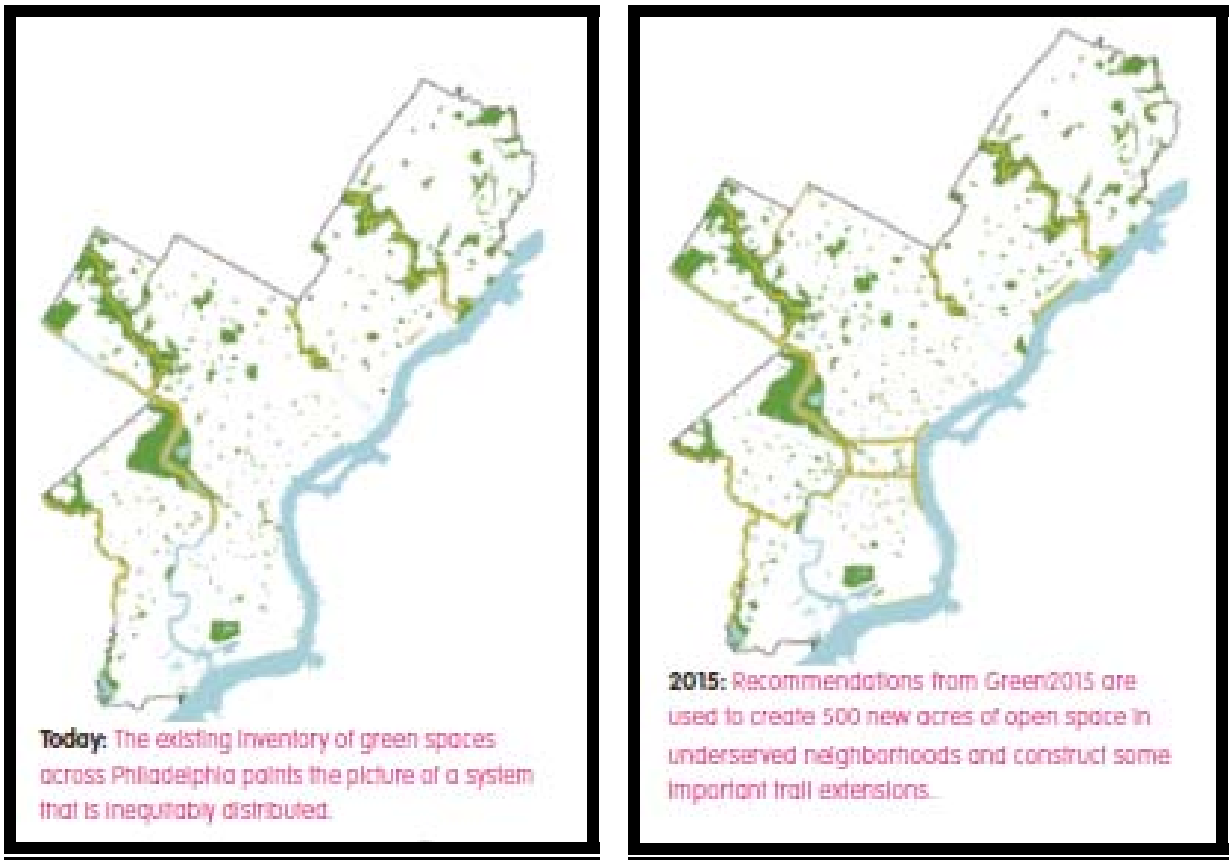
- Public Education Programs
- Annual WaterFest, brochures, on-going classes,
- Trained support staff in Public Works, Planning, Parks and Recreation
- Support from a full time outreach employee in the Rain to Recreation Program
- Environment education coordination with Parks and Recreation
- Incentives to hold 10 year storms on site
- Stream and 100 yr flood plain buffers
- Regional detention for major storm events in areas buffered and leveraged as major parks

Time Line:

-1996 Vision 2020 initiated, completed in August 1997
-2000 Watershed Management Plan
-2000 Watershed Management Division established within Public Works
-2000 Rain to Recreation program initiated in the Public Works Department
-2000 Stormwater Utility Fee- inspections and management of the stormwater system

-2001 Land Disturbance Ordinance created to support the city's erosion and sediment control efforts
-August 2000 voters approved .125 cent sales tax for 5 years (passed by 78% of vote)
-2002 Adoption of a stream set-back ordinance that anticipates recreational uses of stream corridors. (25' stream bank protection and a required outer 25' zone providing a riparian buffer of at least 50 feet from the top of the stream bank. Higher order streams may also require an expanded middle zone that captures 100 year flood plains and slopes greater than 15 percent)
-April 2004 Systems Development Charge (Impact fee passed with the support of the development community.)
-April 2004 Adoption of a Unified Development Code supporting on-site retention of low-level storms
-August 2004 voters approved extension of sales tax through 2010 (passed by over 78% of vote)

Philadelphia, PA



Maps from: Green 2015 report p112

2000 Population: 1,517,550
Established: 1681
Land area: 135 square miles
Location: SE corner of Pennsylvania, between the Schuylkill and Delaware Rivers, approximately 50 miles east of the Atlantic Ocean
Comprehensive Planning:

- 2007 Local Plan Action Plan for Climate Change
- GreenWorks Philadelphia 2009—sustainability plan identifies targets for 2015
- 2010 GreenPlan- open space plan
- Green 2015 – parks acquisition plan focuses on access in underserved neighborhoods

Inventory mapping:

- 2008 Natural Heritage Inventory
- Detailed watershed maps

Regulations:

- Shift water bill calculation to formulas based on impervious surface
- Green Roof Tax credits

- Green Streets program
- Stormwater regulations that create incentives for disconnecting runoff from impervious areas
- Projects must get Philadelphia Water Department concept approval for water, sewer, and stormwater before zoning is considered

Funding:

- 2009 phase in a stormwater utility fee over the next four years, charging non-residential properties based on the ratio of impervious surface area to gross property area

Implementation:

- Triple bottom line analysis of public works projects
- Incentives to retain first inch of rainfall
- Aggressive approach to reduce stormwater flow into combined storm sewers
- Goal 75% of population to live within .5 mile walk to a park
- Focus on inter departmental cooperation led by the Mayor's Sustainability Office

Time Line:

- 1681 William Penn Charter
- 1810 Faire Mounte estate purchased for drinking water
- 1867 Fairmount Park Commission created to managed 4,000 areas
- 1997 Combined Sewer Overflow Long Term Control Plan
- 1998 Fairmount Park Foundation incorporated (name changed to Fairmount Park Conservancy in 2001)
- 1999 Office of Watersheds created by combining: Combined Sewer Overflow, Stormwater Management, and Source Water Protection programs.
- 2004 A Bridge to the Future: Fairmount Park Strategic Plan – a traditional parks and recreation plan looking at recreational services and operations
- 2006 GreenPlan Philadelphia initiated – Green infrastructure plan published in 2010 begins to look at city services in an integrated fashion
- 2007 Local Action Plan for Climate Change
- 2008 Natural Heritage Inventory and Management Recommendations
- 2008 Office of Sustainability established
- 2008 How Much Value Does the City of Philadelphia Receive from its Park and Recreation System? Report from The Trust for Public Land.
- Spring 2009 GreenWorks Philadelphia establishes sustainability policies emphasizing cross departmental collaboration
- Sept 2009 GreenCity:CleanWaters-Combined Sewer Overflow Long Term Control Plan Update
- Oct 2009 Triple Bottom Line Analysis update – compares cost/benefits of green infrastructure and storage tunnel approaches to sewage management
- 2010 The Philadelphia Recreation Department combined with Fairmount Park to become the Philadelphia Department of Parks & Recreation
- 2010 Green 2015 - Park acquisition plan public meetings

Raleigh, NC

2000 Population: 276,093
Established: 1792
Land area: 143 square miles
Location: North Central part of North Carolina, on the fall line
Comprehensive Planning:

- 1976 Capital Areas Greenway
- 1990 Parks Plan – focus on large scale community parks
- 2004 Parks Plan
- 2009- Raleigh Comprehensive Plan 2030 (2030 RCP)

Inventory mapping:

- Green Print map in 2030 Raleigh Comprehensive Plan

Regulations:

- Subdivision Ordinance - development linked land preservation
- Conservation Easements
- Planned Unit Developments
- Development Impact Fees
- Stream Setback Requirements

Implementation:

- Early focus on flood plain protection
- Leverage flood plain buffers to create trails and parks

Funding:

- Annual general fund appropriations
- Storm Water Utility
- Development Impact Fees
- Park Bond Referendums:
    - **1981:** $8 Million Parks Bond
    - **1987:** $10 Million /bond program approved
    - **1995:** $28 Million, 2000: $16 Million
    - **1998:** $2.85 Million from NC Clean Water Management Trust Fund for Neuse River greenway acquisitions
      2000: $16 Million
    - **2003:** $47.25 Million
    - **2007:** $88.6 million bond issue for parks and greenway projects.

Time Line:

- 1969 publication of "Raleigh, Park with a City in It"- greenway concept
- 1973 Greenway commission established
- 1976 Capital Area Greenway Master Plan
- Flood plain ordinance 1970s
- 1984 Urban Forestry Program
- 1990 Parks Plan stressed the need for community parks

- 1996 Neuse River Regional Park Master Plan
- 2004 Parks, Recreation and Greenways Component of the Raleigh Comprehensive Plan
- Green Print

Seattle-King County, WA

Seattle, WA Skyline
http://en.wikipedia.org/wiki/File:Panorama_Kerry_Park_Seattle.jpg

2000 Population: 563,374
Established: 1869
Land area: 92 Square Miles
Location: NW corner of Washington State, on Puget Sound
Comprehensive Planning: 1

- 1994 Comprehensive Plan (the plan is amended annually to keep it current)
- 2006 Envisioning Seattle's Green Future: Open Space Seattle
- 2006 Seattle Parks and Recreation Development Plan
- 2008 Parks Strategic Action Plan 2009-2013

Inventory mapping:

- Envisioning Seattle's Green Future
- Stream Inventories
- Comprehensive Drainage Plan

Regulations:

- Seattle Green Factor- requires 30% of sites to be vegetated
- Development fee-in-lieu program builds a trust fund for stream restoration projects
- Stormwater, Grading and Drainage Control Code

Funding:

- 2000 Pro Parks Levy (property assessment)
- 1998 Stormwater Utility created (fees based upon impervious surface)
- 2008 $146 Million Parks and Green Spaces Levy- property assessment for six years 2009- 2014 (passed with 59% of voters supporting)

- 2008 Parks Department general operating funds come from 3 sources:
    - Parks Fund $36.2 million from a dedicated 10% of tax and license revenues that would otherwise accrue to the General Fund
    - $39.6 million from general fund
    - $27.0 million from fees and charges

Implementation:

- Triple bottom line analysis of public works projects
- Reduce cost of combined sewer overflow by retaining rainfall onsite
    - Public lands focus on green streets
        - Green Streets Program – bio-swales in street rights-of-way
        - Impervious surfaces
    - Private incentives
        - Rain Wise program- incentives for property owners to retain and filter water from low level storms onsite
        - Design assistance
        - Public education programs
- Development fee-in-lieu program that builds a trust fund for stream restoration projects
- Trained planning staff and building inspectors, provided check lists
- Parks Levy (land acquisition, park and trail development)
- Seattle Public Utilities created a design manual of approved techniques

Time Line:

- 1998 Stormwater Utility created
- 2006 Envisioning Seattle's Green Future: Open Space Seattle 2100
- 2008 $146 Million Parks and Green Spaces Levy- property tax for six years 2009-2014 (passed with 59% of voters supporting)